APPLICATION NOTE

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Bridge-tied-load (BTL) amplifier Type TDA8552

high voltage on chip

The TDA8552 from Philips Semiconductors is a two-channel audio power amplifier that provides an output power of 2×1.4 W into an 8 Ω load with a 5 V power supply. The circuit contains two BTL power amplifiers, two digital volume controls and standby/mute logic. Volume and balance of the amplifiers are controlled via two digital input pins which can be driven by simple push-buttons or by a microcontroller. It is contained in a 20-pin small outline package (SOP).

A Philips Semiconductors Application

INTRODUCTION

The TDA8552T is a Bridge-Tied Load (BTL) audio power amplifier capable of delivering 2×1.4 W into an 8 Ω load at a Total Harmonic Distortion (THD) of 10% operating from a 5 V power supply.

The gain of the amplifier can be set by the digital volume control. The gain in the maximum volume setting is 20 dB (low gain) or 30 dB (high gain). The maximum gain is selected via the

PINNING

SYMBOL	*PIN*	*DESCRIPTION*
GND1	1	ground 1, substrate/leadframe
OUT2+	2	positive loudspeaker terminal output channel 2
V_{DD1}	3	supply voltage 1
HPS	4	digital input for headphone sensing
MODE	5	digital trinary input for mode selection (standby, mute and operating)
UP/DOWN1	6	digital trinary input for volume control channel 1
UP/DOWN2	7	digital trinary input for volume control channel 2
V_{DD2}	8	supply voltage 2
OUT2-	9	negative loudspeaker terminal output channel 2
GND2	10	ground 2, substrate/leadframe
GND3	11	ground 3, substrate/leadframe
OUT1+	12	positive loudspeaker terminal output channel 1
V_{DD3}	13	supply voltage 3
GAINSEL	14	digital input for gain selection
IN2	15	audio input channel 2
SVR	16	half supply voltage, decoupling ripple rejection
IN1	17	audio input channel 1
V_{DD4}	18	supply voltage 4
OUT1-	19	negative loudspeaker terminal output channel 1
GND4	20	ground 4, substrate/leadframe

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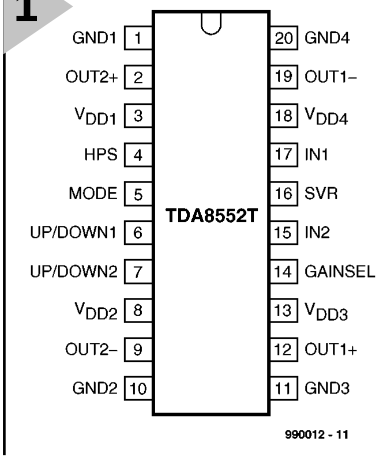

Figure 1. Pin configuration of the TDA8552.

gain selection pin.

The headphone sense input (HPS) can be used to detect if a headphone is plugged into the jack (socket) connector. If a headphone is plugged into the socket, the amplifier switches from the BTL to the Single Ended (SE) mode and the BTL loudspeakers are switched off. This also results in a reduction of quiescent current drain.

The device can be switched to the standby condition, mute condition, or normal operating condition via the MODE pin.

The device is protected by an internal thermal shutdown protection mechanism.

POWER AMPLIFIER

The power amplifier is a bridge-tied load amplifier with a complementary CMOS output stage. The total voltage loss for both output power MOS transistors is within 1 V and with a 5 V supply and an 8 Z loudspeaker an output power of 1.4 W can be delivered. The total gain of the power amplifier can be set at 20 dB or 30 dB via the gain selection pin.

GAIN SELECTION

The gain selection can be used for a fixed gain setting, depending on the application. The gain selection pin must be hard-wired to ground (20 dB) or to V_{DD} (30 dB). Gain selection during operation is not advised since switching is not guaranteed plop-free.

INPUT ATTENUATOR

The volume control operates as a digitally controlled input attenuator between the audio input pin and the power amplifier. In the maximum volume control setting, the attenuation is 0 dB and in the minimum volume control setting, the typical attenuation is 80 dB. The attenuation can be set in 64 steps via the UP/DOWN pin.

Both attenuators for channels 1 and 2 are separated from each other and are controlled via their own UP/DOWN pin.

Balance control can be arranged by applying UP/DOWN pulses to pins 6 and 7.

VOLUME CONTROL

Each attenuator is controlled via its UP/DOWN pin (trinary input):

- Floating UP/DOWN pin: volume remains unchanged
- Negative pulses: decreasing volume
- Positive pulses: increasing volume

Each pulse on the UP/DOWN pin results in a change in gain of 80/64 = 1.25 dB (typical value).

In the basic application, the UP/DOWN pin is switched to ground or V_{DD} by a double push-button. When the supply voltage is connected initially, after a complete removal of the supply, the initial state of the volume control is an attenuation of 40 dB (low volume), so the gain of the total amplifier is –20 dB in the low gain setting or –10 dB in the high gain setting. After power-up, some positive pulses have to be applied to the UP/DOWN pin for turning up to listening volume.

AUTO REPEAT

If the UP/DOWN pin is low or high for the wait time (t_{wait} in seconds) (one of the keys is pressed), the device starts making up or down pulses by itself with a frequency given by $1/t_{rep}$ repeat function). The wait time and the repeat frequency are set with an internal *RC* oscillator with an accuracy of ±10%.

VOLUME SETTINGS IN STANDBY MODE

When the device is switched via the MODE select pin to the mute or standby condition, the volume control attenuation setting keeps its value, provided that the voltage on the V_{DD} pin

Figure 2. Test and application diagram of the TDA8552.

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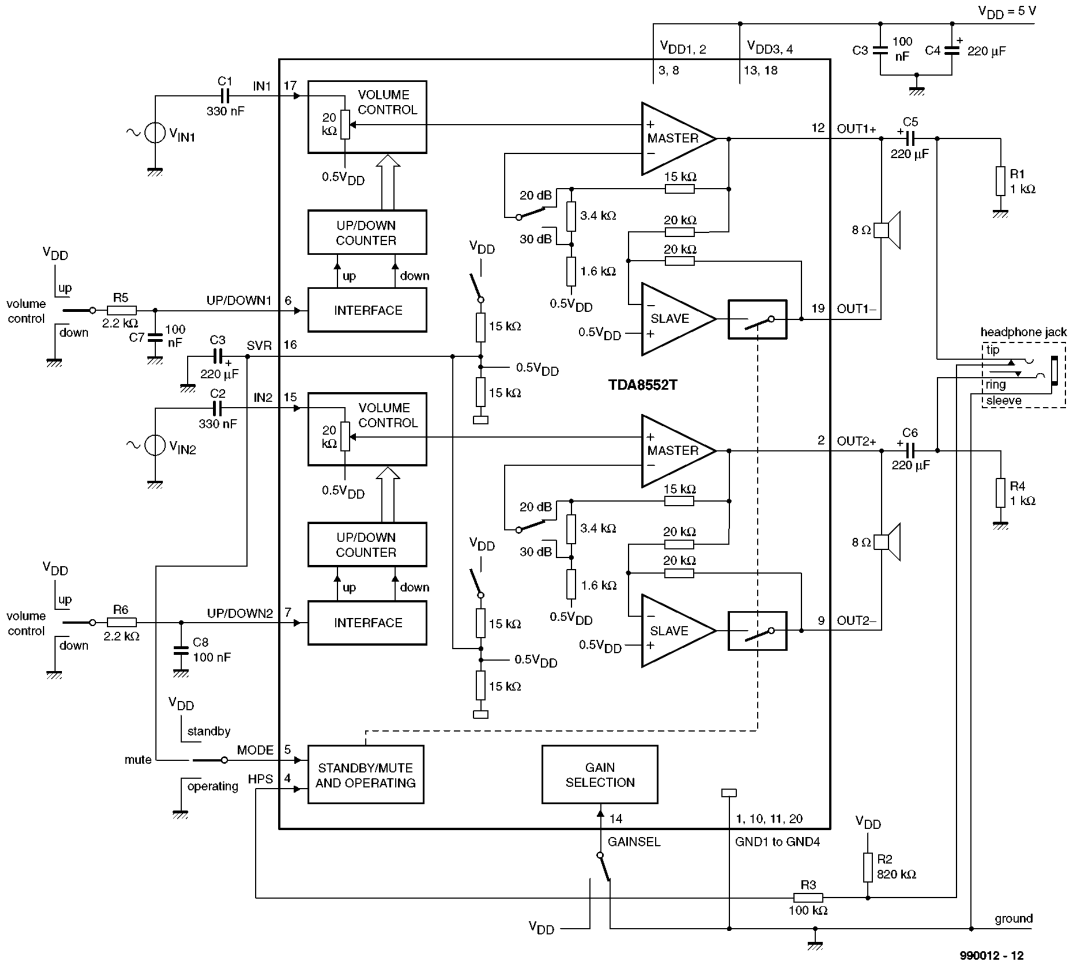

Table 1. DC characteristics.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DD}	supply voltage	operating	-0.3	+5.5	V
V_i	input voltage		-0.3	V_{DD} + 0.3	V
I_{ORM}	repetitive peak output current		-	1	A
T_{stg}	storage temperature		-55	+150	°C
T_{amb}	operating ambient temperature		-40	+85	°C
V_{sc}	AC and DC short-circuit safe voltage		-	5.5	V
P_{tot}	maximum power dissipation	SO20	-	2.2	W
		SSOP20	-	1.1	W

does not fall below the minimum supply voltage.

After the device has been switched back to the operating mode, the previous volume setting is maintained. In the standby mode, the volume setting is maintained as long as the minimum supply voltage is available. The current drain is very low: about 1 µA (typical).

In battery-operated applications, the volume setting can be maintained during battery exchange if there is a supply capacitor available.

MODE SELECTION

The device is in the standby mode (with a very low current drain) if the voltage at the MODE pin is between V_{DD} and V_{DD}–0.5 V. At a mode select voltage of ≤ 0.5 V, the amplifier is fully operational.

In the range between 1 V and V_{DD}–1 V, the amplifier is in the mute condition. The mute condition is useful for using it as a ‘fast mute’; in this mode, the output signal is suppressed, while the volume setting retains its value.

It is advisable to keep the device in the mute condition while the input capacitor is being charged. This can be achieved by holding the MODE pin at a level of 0.5 V_{DD}, or by waiting about 100 ms before applying the first volume-UP pulses.

HEADPHONE SENSING

A headphone can be connected to the amplifier by using a coupling capacitor for each channel. The common ground pin of the headphone is connected to the ground of the amplifier—see **Figure 2**. When the HPS pin is used as illustrated in this diagram, the TDA8552T detects if a headphone plug is inserted into the socket.

When no headphone is plugged in, the voltage level at the HPS pin will remain low. A voltage ≤ V_{DD}–1 V at the HPS pin will keep the device in the BTL mode: the loudspeakers can then be operational. If the HPS pin is not connected, the device will remain in the BTL mode.

When a headphone is plugged into the socket, the voltage at the HPS pin will be set to V_{DD}. The device then switches to the SE mode, which means that the slave power amplifiers at outputs OUT1 and OUT2 are switched to the standby mode. This results in floating outputs: the loudspeaker signal is then attenuated by about 80 dB and only the headphone can operate.

One of the benefit of this system is that the loudspeaker current does not flow thorough the socket switch, which could cause some power loss. Te other benefit is that the quiescent current is reduced when the headphone plug is inserted into the socket.

[990012]

Source: *Data sheet ‘TDA8552T; TDA8552TS 2×1.4 W BTL audio amplifiers with digital volume control and headphone sensing’ Philips Semiconductors, 276 Bath Road, Hayes, England UB3 5BX; telephone +44 181 730 5000; fax +44 181 754 8421; Internet: www.semiconductors.philips.com*

Table 2. AC characteristics.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P_o	output power	THD = 10%; R_L =8 Ω	1.0	1.4	-	W
		THD = 10%; R_L =16 Ω	-	0,8	-	W
		THD = 0,5%; R_L =8 Ω	0.6	1.0	-	W
		THD = 0,5%; R_L =16 Ω	-	0.6	-	W
THD	total harmonic distortion	P_o = 0.1 W; note 1	-	0.15	0.4	%
		P_o = 0.5 W; note 1	-	0.1	0.3	%
$V_{o(n)}$	noise output voltage	GAINSEL. = 0 V; note 2	-	60	100	µV
		GAINSEL. = V_{DD} ; note 2	-	100	-	µV
SVRR	supply voltage ripple rejection	note 3	50	55	-	dB
Vi(max)	a maximum input voltage	THD = 1%; G_v = –50 to 0 dB	-	-	1.75	V
a_{sup}	channel suppression	V_{HPS} =V_{DD} ; note 4	70	80	-	dB
a_{cs}	channel separation		50	-	-	dB

Notes
1. Volume setting at maximum.
2. The noise output voltage is measured at the output in a frequency band from 20 Hz to 20 kHz (unweighted), R_{source} =0 Ω.
3. Supply voltage ripple rejection is measured at the output, with a source impedance of R_{source} =0 Ω at the input. The ripple voltage is a sine wave with a frequency of 1 kHz and an amplitude of 100 mV (RMS) is applied to the positive supply rail, gain select pin is LOW (0 V).
4. Channel suppression is measured at the output with a source impedance of R_{source} =0 Ω at the input and a frequency of 1 kHz. The output level in the operating single-ended channel (OUT+) is set at 1 V (RMS).